

Cryogenic Propellant Storage and Handling Efficiency Improvement

Completed Technology Project (2011 - 2011)



Project Introduction

Stennis Space Center (SSC) is NASA's top annual consumer of cryogenic propellants. Improvements in ground propellant system operations at SSC require having the engineering analysis to analytically determine specific performance metrics and discrete technology development goals to assess need for upgrades. In addition, evaluating suitable ground and space based cryogenic propellant production and handling technology demonstrations is critical.

To accomplish this, accurate thermal modeling is needed to account for the transient behavior of the structure and effect of the insulation configuration, especially if the vessel is thick-walled. Additionally, accurate fluid modeling is needed to account for heat transfer between the liquid and vapor propellant, the pressurant, and the vessel wall. A wide range of heat transfer mechanisms inside the tank, such as film and pool boiling, natural and forced convection, and mixing, must be simulated in order to produce realistic results.

For this project an innovative approach for modeling a cryogenic run tank or storage tank that can simulate the transient behavior during various operations was researched and developed.

The project determined specific performance metrics and discrete technology development goals with which to gage proposed investments in ground propellant systems operations at SSC. Historical center studies/investigations were examined and surveyed on hydrogen and helium conservation and recovery. Additionally, a base analytic model of the Liquid Hydrogen (LH2) propellant tank at SSC's E1 test facility was developed and documented using Thermal Desktop®/FlowCAD®. FloCAD® is a Thermal Desktop® module that allows a user to develop and integrate both fluid and thermal systems within a CAD based environment.

Anticipated Benefits

NASA uses less than 50% of procured cryogenic propellant due to transportation and storage tank heat leak, transient chill down of facilities and launch vehicle/test article cryogenic propellant systems, system purge and inert operations. Currently, as well as over the course of the US Space program, tens of millions of dollars are lost annually due to propellant loss. The metrics used to evaluate cryogenic propellant ground and space based storage and handling technology is desired to analyzed operational improvements and cost savings. Recovering of those millions of dollars could prove invaluable in the future space exploration missions.

Agencies like the Department of Defense, that are involved with launch and test operations could directly benefit similarly to NASA. Other government



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Stennis Space Center (SSC)

Responsible Program:

Center Innovation Fund: SSC CIF

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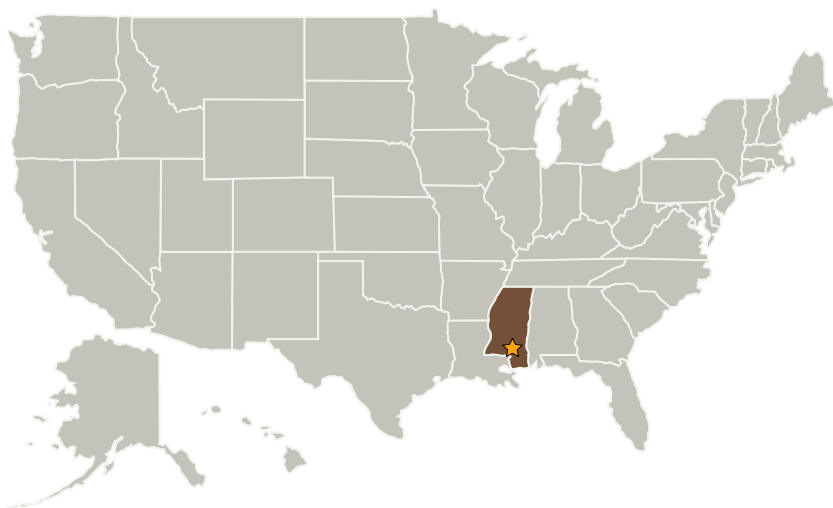
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Benefits to NASA unfunded missions and planned missions includes the ability to save millions of dollars on propellant losses. In addition, if large quantities propellant are not lost, the actual system size for storage and handling could be further reduced, therefore simplifying launch and test operations, while at the same time enabling low cost, and enabling reliable access to space.

Benefits to the commercial space industry would be similar to those that would benefit NASA. The set of modeling tools that can simulate the transient behavior of a cryogenic run tank or storage tank during various operations could be used similarly to lower costs and improve efficiencies in the commercial space industries.

agencies that uses cryogenics or monitor industries that uses cryogenics, could use this capability to improve reliability and reduce costs.

Primary U.S. Work Locations and Key Partners



Project Management

Program Director:

Michael R Lapointe

Program Manager:

Ramona E Travis

Project Manager:

David J Coote

Principal Investigator:

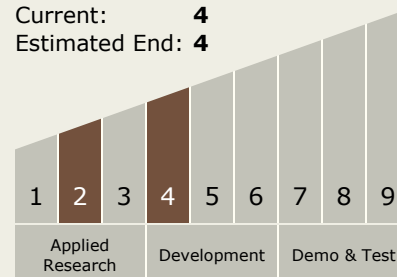
Richard F Wear

Co-Investigator:

Thomas A Piff

Technology Maturity (TRL)

Start: 2
Current: 4
Estimated End: 4

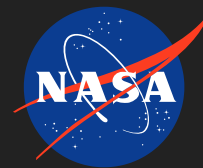


Technology Areas

Primary:

- TX13 Ground, Test, and Surface Systems
 - └ TX13.1 Infrastructure Optimization
 - └ TX13.1.4 Propellant Production, Storage and Transfer

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Organizations Performing Work	Role	Type	Location
★Stennis Space Center(SSC)	Lead Organization	NASA Center	Stennis Space Center, Mississippi
Lockheed Martin Space Systems(LMSS)	Supporting Organization	Industry	Sunnyvale, California

Primary U.S. Work Locations

Mississippi

Images

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(<https://techport.nasa.gov/image/5022>)